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The Labor Market Effects of Part-Time Contributions to Social Security: Evidence from Colombia*

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Abstract

In 2014, Colombia implemented a policy that added flexibilization to labor contracts for part-time workers that reduced the quasi-fixed costs of employing formal workers. We find that the reform increased the probability of entering the formal sector within the targeted population: low-wage, part-time workers. We use administrative employer-employee matched data and leverage variation across cities and industries in demand for part-time work before the reform. We find that, after the tax reform, the change in the total number of formal workers is 6 percentage points higher at firms that use the new contracts relative to their counterparts that choose not to hire low-wage, formal, part-time workers under the new tax form. Mean daily wages temporarily declined after the reform.

Keywords: Labor informality, tax policy, part-time work, labor demand, non-wage labor costs.
JEL Code: J23, J24, J32, J46.

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Los efectos en el mercado laboral de las contribuciones a la seguridad social de tiempo parcial: evidencia de Colombia

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Resumen

En 2014, Colombia implementó una reforma que flexibilizó la contratación de trabajadores formales de tiempo parcial a través de la reducción de los costos cuasi-fijos de contratación formal. Este documento estima los efectos sobre el empleo y los salarios de este cambio en la legislación laboral. Nuestros resultados muestran que la reforma incrementó la probabilidad de ingresar al sector formal dentro de la población objetivo: trabajadores de bajos ingresos laborales y de tiempo parcial. Para la estimación empírica, usamos datos administrativos de aportes a seguridad social (PILA) que nos permiten seguir en el tiempo a empleadores y empleados y una estrategia de identificación que explota la variación entre ciudades e industrias en la demanda por trabajo de tiempo parcial antes de la reforma. Encontramos que después de implementada la reforma, el empleo formal creció, en promedio, 6 puntos porcentuales más en las firmas que usaron el nuevo tipo de contrato de tiempo parcial en comparación con las firmas que no lo usaron. Los salarios diarios medios disminuyeron temporalmente después de la reforma.

Palabras clave: Informalidad laboral, política tributaria, empleo de tiempo parcial, demanda laboral, costos no salariales de contratación.
Código JEL: J23, J24, J32, J46.

Introduction

In Colombia, as in many other countries with contributory social security, employers are required to register their employees in the pension system and to make monthly contributions to their retirement account. Despite this requirement, informal workers (wage earners whose employer did not enroll nor contribute to their pensions) account for approximately half of the labor force in Colombia and in other countries in Latin America (Morales and Medina, 2017; Ulyssea, 2018; ILO, 2018).

Part-time workers are overrepresented among the informally employed. In 2013, 77 percent of all part-time workers (those who work under 40 hours worked per week) were informal. Among full-time employees, the informality rate was 34 percent. The low demand for formal, part-time employment is related to the high quasi-fixed costs of Colombia's mandatory social security system. Before 2014, the monthly minimum wage for full-time employees was the lower bound for the pension system's tax base, regardless of how many days the worker was employed during the month, generating a sharp discontinuity in the cost of formality for part-time and full-time workers. Moreover, low-wage workers who were enrolled in the pension system lost access to the subsidized, non-contributory healthcare system and were instead automatically enrolled in the contributory healthcare program facing an additional fiscal burden.

This paper estimates the employment and wage effects of a reform that lowered the fixed costs of formal labor by allowing pension contributions to be proportional to the number of weeks worked in a month, effectively equalizing the weekly regulatory costs of part-time and full-time workers. The reform, approved in November 2013 and implemented in February 2014, sought to increase low-wage, part-time workers' access to retirement savings by using the weekly minimum wage as a lower bound for pension's tax base. The reform also decoupled participation in the pension system from access to subsidized health care.

We use household survey data and employer-employee matched administrative records on social security contributions to evaluate the impact of this policy. First, we estimate the effect on informal workers' access to the pension system. This analysis relies on household survey data since informal workers are, by definition, missing from official records. Using a two-stage approach, we find that for previously informal, part-time workers the probability of first-time contributions to the pension system increased by 5.4 percentage points after the reform. Importantly, and consistent with the reform's eligibility requirements, we do not find an increase in formalization rates among previously informal workers but in full-time jobs, nor for part-time workers who were not previously informal.

Next, using social security administrative records, we compare the evolution of formal employment, full-time formal employment, hires, separations, and wages between firms that self-select into regularly using the new contract type created by the reform and their counterparts, in the same industries and locations, who do not. Controlling for firm, industry-time, and location-time fixed effects, we find that firms that frequently offer the new formal contracts for low-income, part-time workers exhibited 6 percentage points higher growth rates in formal employment. This increase is driven by a rise in hires of new, low-wage, part-time workers that compensates for a significant decline in full-time, formal employment growth. The growth in separation rates is 3 percentage points higher and mean wage growth is temporarily 1.2 percentage points lower at firms that demand part-time workers under the new tax arrangement relative to their counterparts who do not use the new contracts regularly.

To examine firms' take-up decisions and their effects, we develop a stylized model of labor demand where firms trade-off the regulatory costs of part-time work, the probability of being fined for hiring informal workers, and allow for different productivity of part-time and full-time employees. We propose an empirical strategy based on the model in which we proxy for a firm's exposure to the reform using variation across industries and cities in the demand for low-wage, part-time workers prior to the reform. We find a non-linear, inverted U-shaped relationship between the demand for part-time workers before the reform and the change in formal employment after 2014. Grouping firms into quartiles based on the demand for part-time labor at their industry and location before the reform, we find that total formal employment growth rate after the reform is 3.6 percentage points higher for firms in the second quartile relative to those in the first quartile (the base group). The difference in growth rates drops to 2.8 and 1.6 percentage points respectively for firms in the third and fourth quartiles, with higher demand for part-time labor.

A potential concern is that the increase in formal, part-time work is caused by firms underreporting hours worked for existing full-time formal workers instead of being due to higher formalization rates for part-time workers, as intended by the reform. We do not find systematic evidence of firms switching previously full-time workers to a reported part-time schedule within the same firm. Instead, most of the workers hired using the new contract type created by the reform transition to these jobs from outside the formal sector or from formal, full-time jobs at other firms.

Our results are consistent with the reform successfully reducing the cost of hiring formal, part-time workers as it addressed the disparities in the regulatory costs across different work schedules. The new regulation gave employers more flexibility in determining the number of days per month to employ a worker without imposing higher tax rates for part-time workers.

This paper contributes to the literature analyzing how changes in the institutional environment affect labor markets and various job attributes such as work schedules (part-time versus full-time employment) and informality rates. Prior work in this area focuses on the impact of enforcement or taxes on labor demand. Almeida and Carneiro (2012) find that stronger enforcement increases labor supply in the formal sector and depresses wages. Meghir et al. (2015) instead find increases in wages without an increase in unemployment. Samaniego de la Parra and Fernández Bujanda (2021) find that increasing the probability of getting caught with informal workers increases firms' incentives to formalize informal employees but leads to less hiring and more separations in the formal sector, thus decreasing total formal employment.

A related literature employs structural models to simulate the impact of changes in the relative cost of formal contracts. Ulyssea (2018) and Haanwinckel and Soares (2021) find that lowering payroll taxes increases the demand for formal labor. Calibrating a model with informality to Colombia's economy, Anton (2014) predicts an increase in formal and total employment accompanied by higher formal wages after 13.5 percentage point decrease in non-wage labor costs. Empirical analyses contradict some of these theoretical predictions. In Colombia, Morales and Medina (2017) find an increase in formal job creation with negligible effects on wages, while Bernal et al. (2017) find an increase in employment and average firm wages. In contrast, according to Gruber (1997) the incidence of a large payroll tax decrease in Chile fell mostly on wages, with no impact on employment.

Our work contributes to this literature examining the determinants of firms' labor demand and its responses to changes in policy. However, our analysis focuses on the impact of differential quasi-fixed regulatory costs between part-time and full-time employees in a context with high informality. Employers choose the optimal share of part-time or full-time workers to hire, and for each of these work schedules, they decide whether to abide with labor regulation and enroll the worker in the mandatory social security system with the corresponding payroll taxes and fixed costs or to hire them informally with the associated risks of a fine.

Prior work finds that changes in the relative cost of full-time workers, measured through a rise in health insurance premiums, affect labor demand. Cutler and Madrian (1998) argue that increases in labor's fixed costs cause an increase in hours worked and a decline in total employment. Baicker and Chandra (2006) also find a decline in employment probability, but a decrease in hours. The difference in these findings is driven by a rise in the demand for part-time workers who are not eligible for employer-provided health insurance. Our analysis extends this literature to a context with a high level of informality where firms can exploit regulation avoidance as an additional margin when responding to changes in the relative cost of part-time versus full-time workers.

Our findings on the effect of allowing part-time contributions to social security on job creation are in line with recent literature examining the impact of regulation on labor market dynamism. Instutional features such as non-wage labor costs can introduce labor market frictions affecting job creation and destruction, thus limiting firms' ability to respond to shocks (Bassanini & Garnero, 2013; Blanchard & Portugal, 2001; Bottasso, Conti, & Sulis, 2017; Gómez-Salvador et al., 2004; Haltiwanger, Scarpetta, & Schweiger, 2014; Florez, Morales, Medina & Lobo, 2020). Our findings indicate that job creation and separation both increase after eliminating the gap in quasi-fixed costs between part-time and full-time workers.

The remainder of this paper is organized as follows. In the next section, we explain the institutional details of Colombia's social security system. In section III, we describe the data. Section IV presents stylized facts on the reform's take-up, the targeted population, and firms' compliance with eligibility requirements. Section V develops a stylized model of firm labor demand. We use the model to guide our empirical strategy outlined in section VI which also contains our main results. Section VII concludes.

I. Colombia's Social Security System and 2014 Reform (Decree 2616)

The contributory social security system in Colombia is comprised of four main pillars: pensions,[1] healthcare, work-related hazards insurance (ARL), and subsidies for low-income workers (*cajas de compensación*[2]). These benefits are financed through payroll taxes and fixed contributions from employers and workers. Employers are required to register their workers in the contributory system

[1] There are currently two pension schemes in place in Colombia: The government-administered and subsidized pay-as-you go pension system (PAYGO) and private pension funds, which are non-taxable individual savings accounts. The PAYGO system has retirement age and total weeks accrued minimums. In the private system, workers must save enough to cover at least 110% of a monthly minimum wage for their expected lifetime.

[2] *Cajas de Compensación* provide education and food subsidies to all formal low-income workers, and subsidized entertainment and educational activities in their facilities.

and pay monthly contributions to finance each of the social security system's pillars. Employers are also responsible for deducting the workers' share of social security contributions from their paychecks and transferring them to the social security system. Formal work arrangements are also subject to various labor regulations that carry fixed employment costs.[3]

Given the low levels of compliance with the requirement to employ workers formally, Colombia also has a non-contributory, subsidized system to provide health care for informal workers with verified low-income levels. Only workers included in a registry known as SISBEN or "Census of the Poor" are eligible to participate in the non-contributory healthcare system. Everyone in the registry is assigned a score based on a set of socioeconomic characteristics. Individuals with scores below a certain threshold are eligible to receive government subsidies, transfers, and access to the non-contributory healthcare system. It is financed through general taxation and covers almost all low-income households.

As a result, more than 90% of the Colombian population has healthcare coverage, half of which is via the subsidized system (Ministry of Health and Social Protection, 2019). Prior to the 2014 reform, contributions to pensions and healthcare benefits were bundled. Due to this bundling, formally employed workers gained access to the pension system but automatically lost the healthcare subsidy.

The cost of hiring formal workers is high, more so for part-time workers before the 2014 reform. The payroll tax for full-time workers was equivalent to 33% of the minimum between the worker's monthly wage and the *monthly* minimum wage. Employers' *de-jure* contribute three-fourths of the cost[4,5] and approximately half of the payroll tax is directed to the worker's pension fund. Monthly minimum wages were determined based on a full-time work schedule; hence, the lower bound for contributions to the social security system were relatively higher for part-time workers. For example, the non-wage labor costs for a part-time worker employed for 15 days a month earning 50% of the monthly minimum wage were the same than for a full-time worker earning the monthly minimum wage since the tax base would be the same for both. The total labor cost for the formal

[3] These costs include 15-day paid vacation per year of tenure, contributions to a severance fund, end-of-the year bonus equivalent to one month's salary, maternity leave, minimum wage and overtime pay.

[4] The 33% tax rate is levied as a 25% tax for employers and an 8% tax for workers. Employers' tax is distributed as follows: 12 p.p. go to pensions, 8.5 to contributory healthcare, 4 to *cajas de compensación* and 0.5-4.3 p.p. to insurance (based on the job's hazard rate). Workers' 8% tax rate is evenly distributed between pensions and healthcare.

[5] Since 2012, employers with 3 or more employees with salaries between 1and 10 monthly minimum wages are exempt from healthcare and *cajas de compensación* contributions (see Morales and Medina (2017)).

part-time worker was twice the cost of the full-time worker even though their daily wage was the same (Figure 1, panel a).

Employers can hire part-time and full-time workers informally to avoid payroll taxes and other non-wage labor costs. Informal work arrangements violate labor regulations and various tax laws and can carry penalties of up to 400 monthly minimum wages. Although labor inspections are not very common in Colombia, individuals can report non-compliant employers at a Workers' Office located across all major cities in the country. In such case, a labor inspector is assigned to the case and has to call both parties to settle the dispute. In general, employees have the upper hand in these settlements.

In November 2013, Colombia's Congress approved a reform, called Decree 2616 of 2013, modifying the minimum mandated contribution to the social security system. The reform was implemented in February 2014 and effectively introduced part-time contributions in Colombia. The goal of the reform was to homogenize the regulatory costs of employing low-wage, part-time workers, thus reducing the barriers to enter the formal sector. This reform changed the tax base's lower bound from a *monthly* to a *weekly* minimum wage (see Table 1); it also decoupled the pensions system from the subsidized healthcare system. Previously informal workers could be registered in the formal sector's pension system without also having to make contributions to healthcare benefits.

Table 1. Mandated Minimum Pension Contribution by Number of Days Worked After the Implementation of Decree 2616

Days worked during the month	Tax base for social security contributions lower bound
1-7 days	¼ of the monthly minimum wage
8-14 days	1/2 of the monthly minimum wage
15-21 days	3/4 of the monthly minimum wage
22 or more days	Full monthly minimum wage

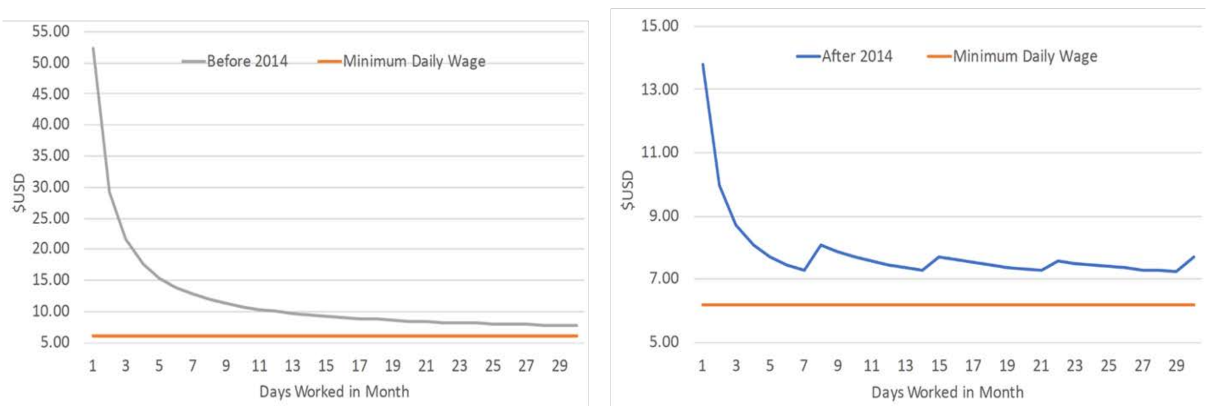
Source: Decree 2616 of 2013.

The reform created a new tax category known as "type 51" employees. To register a worker as a "type 51" worker, employers follow the same process they did before when hiring a formal worker: visit an online registration system, fill out the workers' information, and select the worker type, which now includes a "type 51" option, from a drop-down menu.

Not all workers are eligible to be employed as "type 51" employees. Decree 2616 requires that "type 51" employees: a) have monthly wages below the monthly minimum wage, but daily wages that are at or above the monthly minimum divided by 30, b) work less than 30 days in the month, and c) are part of the SISBEN registry and are covered by the subsidized healthcare system.[6] The first two requirements restrict the number of work-days and pay for "type 51" workers.[7] The last requirement effectively implies that only workers transitioning from the informal, subsidized healthcare system can be offered a "type 51" contract. Neither employers nor workers can easily manipulate the SISBEN score, specially not in the short term, to be eligible for subsidized healthcare.[8] In the next section we show that workers' transitions to the formal, pension system after the reform are not indicative of the new contract type being used to lower the costs for non-eligible workers.

Figure 1: Cost of Formal Labor by Number of Days Worked in Month

(a) Before 2014 **(b) After 2014**



Note: Including variable and quasi-fixed costs of social security before and after 2014 (the implementation of Decree 2616 of 2013). Source: Own calculations using GEIH survey data.

II. Data

Our analyses rely on two data sources: the Colombian Household Survey (GEIH)[9] and administrative records from contributions to social security (PILA[10]). We describe each of these

[6] The last requirement was meant to guarantee that "type 51" workers maintain access to health care even though neither they nor their employers have to pay into the contributory health care system.
[7] Employers could potentially manipulate these requirements by under-reporting the number of days worked or paying a share of the worker's wage "under-the-table."
[8] When SISBEN was first introduced score manipulation was common (see Camacho and Conover (2011)). This changed after 2009 when Colombia implemented stricter controls and frequent registry updates.
[9] GEIH stands for *Gran Encuesta Integrada de Hogares.*
[10] PILA is the acronym for the *Planilla Integrada de Liquidación de Aportes* which translates to Integrated Contributions Settlement Worksheet.

data below and highlight their respective contributions and limitations in the context of our analyses.

The GEIH is a monthly, cross-sectional household survey with comprehensive information on sociodemographic characteristics, employment status, hours worked, monthly labor income, among other labor market participation details for a representative sample of the population. This survey is the source for Colombia's official labor market statistics because, unlike administrative records, it includes both formal and informal work arrangements. We distinguish between informal and formal contracts using individuals' self-reported access to Colombia's subsidized health system (only available to informal workers prior to the reform) and reported contributions to the formal pension system.

GEIH data has two limitations for our analysis: first, workers report the number of hours worked per week, but not the number of days worked per month. In Colombia, *de-jure* full-time workers are those working 6 days a week, 8 hours per day. However, *de-facto* full-time employment includes individuals working 5 days per week. Moreover, part-time contracts can include 8-hour per day arrangements, where the individual is employed for 1 or 2 weeks a month. The GEIH cannot capture these nuances in part-time and full-time arrangements. We abstract from them and identify part-time workers as those that report being employed for less than 40 hours in the previous week.[11]

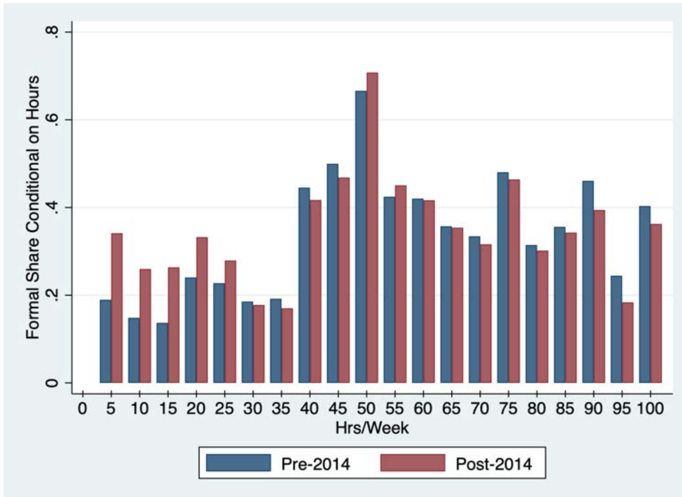
The second challenge posed by the GEIH is its cross-sectional structure. It prevents us from directly observing transitions in or out of the pension system, and hence, of the formal sector. We overcome this limitation by using workers' self-reported information on the time that they have accrued so far in the pension system. This information allows us to identify recently formalized, previously informal workers, as those who are currently registered and have contributed to the pension system for less than a year.

According to the GEIH, 16.6 percent of private-sector and domestic employees earning less than 1.5 times the monthly minimum wage work 40 hours per week or less.[12] Before 2014, formalization rates among part-time workers was, on average, 10 percent. The share of part-time workers contributing to the pension system increased to 13 percent after 2014. The rise was driven

[11] As a robustness check, we also consider 35 hours per week or less as an alternative definition for part-time work.
[12] Most of these workers (90%) work 35 hours per week or less.

by new contributions among individuals working 25 hours a week or less, the group with historically the lowest formalization rates (Figure 2).

Figure 2: Share of formal employment by hours worked, before and after 2014.



Note: The sample includes all private sector and domestic workers with monthly labor income less than or equal to 1.5 times the monthly minimum wage. Each bar shows the share of workers that contribute to the pension system within the respective hour-worked bin. Each 5-hour work bin includes the upper bound, e.g., the 10-hour bin includes individuals who report working between 6 and 10 hours the prior week.
Source: Own calculations using GEIH.

The Colombian Ministry of Health and Social Protection collects all payroll tax payments and pension contributions in an online system known as PILA. From PILA's administrative records, we obtain an employer-employee matched panel that includes data on the amount contributed to each worker's retirement fund for each employment month, their wage, age and gender, the number of days worked in the month, the employer's industry and location for the universe of formal employment contracts in Colombia.[13] Both employers and workers have unique tax identifiers so we can track any firm's[14] full formal payroll and each worker's formal labor market trajectory. We also directly observe the "tax form" that the employer chooses to register the worker in the pension system and whether this changes through time. This information allows us to distinguish between changes in firms' employment attributable to full-time workers, part-time workers ineligible for the reduced cost tax form, and "type 51" workers.

[13] We access our data through Banco de la República. For the analysis at the industry or industry-city level, Banco de la República provides access to the full universe of formal employer-employee matches. However, due to computational constraints, in the case of the data at employer-month level, Banco de la República selects a random sample of 25% of the total universe of employers and provides us access to the full payroll and social security contribution history for these subsets of employers.
[14] We use the terms "firm" and "employer" interchangeably.

The GEIH and PILA serve as complementary sources for different analyses. The GEIH provides information on a representative, cross-section of informal and informal workers. Meanwhile, PILA includes the universe of formal employment, and its dynamics, with detailed information on the tax form. However, it excludes all types of informal arrangements. In PILA, we cannot distinguish between separations to unemployment and transitions to informality.[15]

III. Take-up Stylized Facts

A. Compliance with Eligibility Requirements

Decree 2616 intended to decrease the cost of enrolling low-income, part-time, previously informal workers to the formal pension system. The targeted group was: 1) informal (i.e., enrolled in subsidized health care), 2) part-time workers, and 3) with monthly wages below the monthly minimum but with daily wages above the monthly minimum wage divided by 30. Due to the first requirement, employers should not be able to use the reform to reduce the labor costs for already formalized individuals by cutting their hours. The third requirement prevents the enrollment of part-time, informal workers with wages below the daily minimum wage, unless the employer increases the worker's wage to match the daily minimum.

In this section, we examine whether the probability of entering the pension system, for the first time, changed for the group targeted by the reform, or if there is evidence of use among the ineligible population. First, using data from the GEIH survey from 2010 to 2019, we focus on employed individuals with wages around[16] or below minimum wage. We group these workers into 4 categories based on the combination of 2 indicator variables: access to subsidized health care, and working less than 40 hours with a daily wage close to[17] the minimum.[18]

Next, we identify new pension system entries based on total time accrued in the pension system. We consider the worker a new entrant if they have contributed for a year or less. We focus on recent labor market entrants (16-25 years old). The goal of this sample restriction is to improve the likelihood that the total accrued time reflects the respondents first employment spell, rather

[15] Reassuringly, the number of formal workers is similar between the two data sources as shown in Figure A2 in the Appendix.
[16] Up to 1.05 times the monthly minimum wage.
[17] At least 0.95 times the monthly minimum wage.
[18] See Table B2 in the Appendix for additional detail on these categories and their implications for eligibility.

than the cumulative time contributing over several formal employment spells.[19] To reflect the reform's low-wage eligibility criteria, we further restrict our sample to individuals earning no more than 5 percent above the monthly minimum wage. On an average month, these workers account for 24% of the total employed population and 41% of employment for 16 to 25-year-olds in Colombia.

Let $new\_pension_{i,t}$ be an indicator function equal to 1 if in period *t* worker *i* has a year of less of accumulated contributions to the pension system, and zero otherwise. We use the following specification to examine the change in the probability of new enrollments to social security:

$$\begin{aligned} new\_pension_{i,t} = {} & \beta_1 eligible\_pt_{i,t} + \beta_2 informal_i + \beta_3 eligible\_pt_{i,t} \times informal_i \\ & + \beta_4 informal_i \times post_t + \beta_5 eligible\_pt_{i,t} \times post_t \\ & + \beta_6 eligible\_pt_{i,t} \times informal_i \times post + X'_{i,t}\alpha + \lambda_{s\times c\times o\times t} + \epsilon_{i,t} \end{aligned} \tag{1}$$

where $eligible\_pt_{i,t}$ is an indicator function equal to 1 for part-time workers with hourly wages making them eligible for registering in the pension system (i.e. their hourly wages are at or above the hourly wage minimum), $informal_i$ equals 1 if the worker is in the subsidized health care system and zero otherwise, and $post_t$ is one for all time periods after 2014. $X_{i,t}$ is a set of worker-level controls including education fixed effects, gender, age and age squared, marital status, whether there are children in the household under the age of 10, and presence of children interacted with gender. Our preferred specification includes labor market-time fixed effects ($\lambda_{s\times c\times o\times t}$) where a labor market is defined using 1,900 industry×city×occupation categories.

Note that in our specification, the indicator for informality is not time-varying. This is meant to reflect the fact that access to the subsidized health-care system, which we use to identify informal workers, requires, first, being included in the Census of the Poor (SISBEN) and, second, being assigned a score below the poverty threshold. Both requirements are difficult to manipulate by the individual or the employer, and hence we assume to be constant.

Table 2 presents the estimated coefficients from equation (1). First, note that before 2014 the probability of contributing to the pension system is 2.4 percentage points lower for part-time workers with wages below the daily minimum. This finding is consistent with the high costs of registering part-time workers who earn less than the minimum monthly wage. Prior to the reform,

[19] Our goal is to identify individuals in their first formal spell. However, workers can have a total accrued time under a year across different spells due to transitions in and out of formal employment. The results are similar, albeit with smaller magnitudes, if we instead include all workers ages 16 to 75.

informal workers had to renounce access to the subsidized health care, so it is not surprising that we find a negative (-17 percentage points) and statistically significant association between informality and the probability of entering the pension system. Before the reform, the interaction between part-time employment and informality was not a statistically significant determinant of the probability of enrollment in pensions. After the reform, conditional on having access to the subsidized health care system (i.e., on being a previously informal worker), the probability of entering the formal pension system for the first time is 5.4 percentage points higher for part-time workers.

Table 2: Probability of new entry to the pension system for young, low-wage employees

Linear Probability Model. Dependent Variable **I[**Time Accrued to Pension ≤ 1 year]	
eligible part-time	-0.024**
	(0.010)
informal	-0.170***
	(0.004)
eligible part-time X informal	-0.020
	(0.019)
eligible part-time X post	-0.032**
	(0.013)
informal X post	-0.082***
	(0.005)
eligible part-time X informal X post	0.054**
	(0.024)
No. of workers	137,196
R-squared	0.35
Fixed Effects	IndustryXAreaXOccupationXTime
No. Of Absorbed Labor MarketsXTime FE	19,023

Note: This table contains the estimated coefficients ($\hat{\beta}$) from equation (1). The sample includes 16- to 25-year-old employees earning a monthly wage equal or less than 1.05 times the monthly minimum wage. Controls include indicators for educational attainment, age and age squared, marital status, gender, number of children under the age of 10, and an interaction of these last two controls. The dependent variable is an indicator function equal to 1 if the individual has a year or less contributions accrued to the formal pension system, and zero otherwise.

It is important to note that in the post-reform period, satisfying only one of the eligibility criteria is associated with a lower probability of new contributions to the pension system. We conclude that after the reform new entries to the pension system increased for part-time, previously informal workers, but not for either part-time, already formal workers nor for informal, full-time workers. These findings are consistent with an increase in contributions to the pension system within the population targeted by the reform.

In the prior analysis, we assume that informality is a fixed characteristic in the short-term. Formally employed workers cannot easily access the subsidized health care system, and thus transition to informality. This requirement makes it unlikely that employers used Decree 2616 to decrease their labor costs by reducing (or under-reporting) the number of days worked for their currently employed full-time workers or by poaching full-time workers from other firms to hire as part-time employees. We analyze whether this is in fact the case using PILA's administrative records which allow us to track the complete formal employment history of workers that are hired under the new "type-51" contract.

For the universe of workers who are ever employed under the part-time contribution regime, we first identify the employer and date when this part-time contract started. We then track the worker back in time to identify whether they ever had a prior, formal contract. Similarly, we follow the worker's trajectory to the future and identify their next, immediate contract. We find that only 3.5 percent of all part-time pension contributors were previously employed at the same firm. This indicates that while there is some evidence of employers potentially misusing the Decree, these contracts represent a small share of part-time, formal employment. Further, type-51 contracts is the first instance of formal employment for 48 percent of employees hired under the new part-time, formal contracts.

B. "Type-51" Take-up

By 2019, there were 60,000 formal workers with part-time pension contributions ("type 51") working across 10,000 employers. Type-51 contributors represent only a small fraction (0.4%) of total formal employment. However, they are present across many industries and cities in Colombia. By 2019, 96 percent of all industries[20] in the country had had at least one firm frequently using type 51 contributions in their payroll. These firms were located across all of Colombia's 23 major cities. Out of 1,875 industry-city groups, 38 percent had at least one firm using the new, part-time formal contracts regularly.

We begin by grouping firms based on the frequency of their use of type 51 workers. For each firm and each month that it is active in the formal sector,[21] we count the number of type 51 workers it has registered in the pension system. We then calculate the mode of the number of type 51 workers across all months that the firm is active in the formal sector from 2014 to 2020. We categorize a

[20] We consider 92 distinct 2-digit industries.

[21] Active firms in the formal sector are those with at least one employee registered in PILA.

firm as a "take-up" firm if the mode is greater than zero, that is, if the firm uses type 51 workers on at least half of the months that it is active from 2014 onwards.

Table 3 presents summary statistics for "take-up" and "non-take up" firms during the 3 years prior to the reform being announced (2010-2013). We exclude firms that were not active for at least one month after the reform was announced. Firms that regularly employed type 51 contributors had fewer total formal workers than those that do not use the new part-time fiscal form regularly.[22] With regards to other variables, both groups are similar on average. Conditional on being active for at least one month after 2014, formal job creation, wages, firm age, and survival rates (measured by the total number of active months) are not statistically different across the two groups in the period before the reform.

Table 3: Firm Mean and Standard Deviation from 2010-2013 by Use of Type 51 Workers

	Mode (Type 51 Workers) > 0			
	Yes		No	
	Mean	(std. dev.)	Mean	(std. dev.)
No. of Workers	15.46	(49.76)	19.45	(66.53)
Formal Job creation	1.16	(8.89)	1.08	(8.05)
Formal Hires	2.15	(12.53)	1.95	(11.23)
Median wage (2014 $USD)	1.99	(1.33)	2.03	(1.58)
% workers 24	2.40	(9.08)	2.88	(12.25)
% workers 25-44	8.89	(29.82)	11.51	(40.98)
% workers 45-59	3.43	(10.92)	4.26	(15.98)
Firm Age	31.71	(18.66)	31.13	(18.42)
% male workers	0.52	(0.35)	0.57	(0.34)
Ln(Real GDP)	10.99	(1.08)	11.01	(1.11)
No. Active Months	102.76	(38.03)	99.19	(43.32)
No. Obs (firm-months)	55,246		2,825,330	
No. Firms	8,809		269,370	

Note: The sample includes firms with at least one active month in the formal sector between 2014 and 2020. Source: Own calculations using PILA.

We next compare firms that self-select into frequently using the new, type 51, part-time contracts to those that do not regularly hire workers under the new tax form. Specifically, we compare the set of firms who make part-time contributions on behalf of at least one of their employees (i.e., firms that hire type 51 workers) during most of the months that the firm is active in the formal

[22] Consistent with this finding, a stylized model we develop in section V predicts a negative correlation between the initial number of formal workers at a firm and demand for type 51 workers.

sector on or after 2014 against all other firms with at least one active month in the formal sector during the post-reform period.[23] We do not aim to recover a causal treatment parameter from this analysis as we acknowledge that time-varying observable and unobservable firm characteristics affect the likelihood that a firm regularly uses the new contract type, as well as their employment growth and wage dynamics. Instead, the goal of this analysis is to provide an initial examination into the differences in formal and full-time employment growth across "type-51 users" and "non-users," including the effect due to those unobservable factors that lead firms to choose to hire formal, part-time workers under the new contract type in the first place. We include firm fixed effects so that neither the difference in outcomes nor the self-selection into using part-time, formal workers are driven by unobservable time-invariant firm characteristics. Industry-time and city-year fixed effects similarly rule out factors that vary within industry or locations across time as the causes for the different outcomes.

Let $type\ 51_{j,t}$ be the number of type 51 workers employed at firm j in month t. Further, let $I[mode(type\ 51_{j,t}) > 0]$ be an indicator function equal to 1 if the mode of $type\ 51_{j,t}$ across time is greater than zero. Equation (2) below presents our main specification:

$$Ln(y_{j,t}) = \beta\ I[mode(type\ 51_{j,t}) > 0]\ \times post_t + x'_{j,t}\alpha\ + \lambda_j + \gamma_{s\times t} + \delta_{c\times y(t)} + \varepsilon_{j,t} \quad (2)$$

where $y_{j,t}$ stands for the outcome of interest for firm j in month t. λ_j, $\gamma_{s\times t}$, $\delta_{c\times y(t)}$ are firm, industry-time, and city-year fixed effects. $x'_{j,t}$ is a vector of time-varying firm characteristics, including firm age and the share of workers by gender and age groups.[24] The variable post is equal to one on and after January 2014.

Table 4 displays the estimated $\hat{\beta}$ coefficients from equation (2) and their standard errors. Each row presents a different dependent variable.[25] These results indicate that, after the reform, the change in the total number of formal workers is 6 percentage points higher at firms that use type-51 contracts relative to their counterparts that choose not to hire low-wage, formal, part-time

[23] Results are similar across all measures. We use the mode as our preferred specifications since it is more conservative when defining firms as "frequent users." We also performed sensitivity analyses which consider different thresholds for the value of these central tendencies. Again, our results are robust to these considerations.
[24] We also consider specifications where we separately include either cityXtime or industryXtime fixed effects instead of both sets of fixed effects simultaneously. Results are similar and we present the specification with all sets of fixed effects as our preferred, baseline results. For specifications that do not include cityXtime fixed effects, we add a control for the natural logarithm of state GDP.
[25] When the dependent variable refers to a flow (i.e., hires or separations) we use the natural logarithm of the variable plus 1 given the prevalence of zeros. The results are similar if we instead use the inverse hyperbolic sine.

workers under the new tax form. Full-time formal employment is lower with firms substituting towards part-time employment after the reform. Formal hires and job creation are 3.4 and 2.6 percentage points higher among firms using the new, part-time contributions. Separation rates are also relatively higher after the reform for these firms, compared to the set of firms that do not hire part-time, formal workers. The change in mean wages at firms that use type 51 workers is 1.3 percentage points lower for "type 51 users" relative to firms not using part-time, formal employees. This finding is consistent with the minimum wage eligibility requirement for type-51 workers. Due to the decline in formal, full-time workers and the increase in formal part-time employment, the mean number of formal workdays at firms using the new contract type declines by a magnitude similar to the decrease in full-time employment.

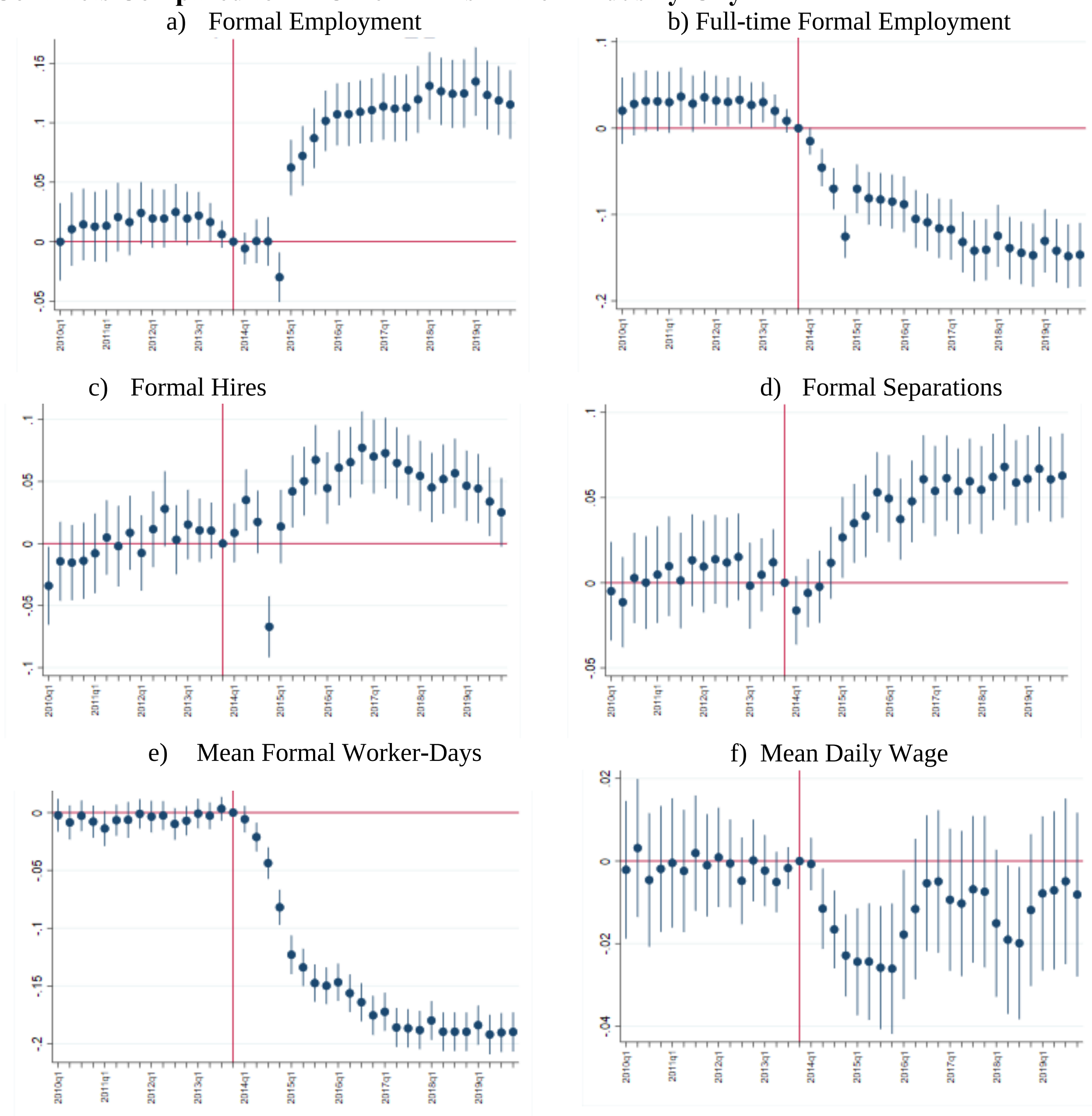
Table 4: Mean Growth Rate Differences Between Firms that Frequently Use Type-51 Contracts Compared to All Other Firms in their Industry-City

Dependent Variable (Natural Logarithm)	**Post X I[Mode(Type51) > 0]** Coef.	(s.e.)	**R-squared**	**No. of Obs.**
Formal Workers	0.060***	(0.012)	0.910	8,645,440
Full-Time Formal Workers	-0.128***	(0.014)	0.904	8,636,694
Formal Job Hires	0.034***	(0.009)	0.574	8,645,440
Net Formal Job Creation	0.026***	(0.006)	0.259	8,645,440
Formal Job Separations	0.032***	(0.008)	0.616	8,645,440
Net Formal Job Destruction	0.023***	(0.006)	0.252	8,645,440
Mean Daily Wage	-0.013*	(0.007)	0.834	8,635,998
Mean Worker-Days per Month	-0.129***	(0.005)	0.506	8,620,957

Note: This table contains the estimated coefficients on the interaction term from the treated and post-reform indicator ($\hat{\beta}$) in equation (2). In specifications where the dependent variable is a flow (hires, separations, job creation and destruction), our specification uses the natural logarithm of 1 plus the dependent variable. The sample includes 278,179 firms with at least one active month in 2014 or onwards located in one of Colombia's 23 major cities or any city in Cundinamarca (the state where Bogota is located) – 44 cities in total. Sectors include agriculture and mining, manufacturing and construction, and services. All specifications include firm fixed effects, sector-year-month and city-year fixed effects. We cluster standard errors at the firm level.

We also consider an alternative specification for equation (2) that substitutes the post-reform indicator variable for a set of quarterly dummies. This specification allows us to compare firms using type-51 workers to their counterparts in the same industry and location at various points in time. Figure 3 plots the estimated difference in growth rates for the set of firms that opt-in to formal, part-time contracts for low-wage workers (i.e., type 51 contracts), relative to firms that do not. We use the quarter when the reform was announced (4th quarter of 2013) as the baseline period for both groups.[26]

Figure 3: Quarterly Growth Rate Differences Between Firms that Frequently Use Type-51 Contracts Compared to All Other Firms in their Industry-City



Note: Figure 3 plots the estimated $\hat{\beta}$ coefficients from a modified version of equation (2) where we substitute the post indicator variable with a set of quarterly dummies. The baseline period, marked by the vertical red line in each plot, is the 4[th] quarter of 2013, when the reform was announced. The bars denote 95% confidence intervals. Each dot indicates the difference in the natural logarithm of the outcome variable between the treated group and the control group in quarter t relative to the baseline time-period. Firms that frequently use type-51 contracts are those with at

[26] The reform was implemented later, during the 1[st] quarter of 2014. Our results are similar when we widen or change the baseline period to include the reform's implementation instead of its announcement.

least one type-51 employee in most of the months when the firm is active in the formal sector. All other firms in the same industry-city with at least one active month in the formal sector on or after 2014 compose the control group.

Although, as we have previously mentioned, firms self-select into using type-51 contracts, we do not find evidence of significantly different growth rates prior to the reform's implementation between the "type 51 users" and "non-users" in the same industry and location for most of the labor market outcomes of interest. Full-time formal employment is the single exception, where we do find statistically significant pre-trends between treated and control firms. Firms hiring part-time, formal workers under the new contract type are on average smaller (see Table 3) and grew at a faster rate in the pre-period (see Figure 3 panel b).

Differential growth rates in the outcomes of interest do not begin until a year after the reform was implemented. Starting in 2015, firms that self-select into using type-51 contracts exhibit permanent higher total formal employment growth rates, and decreases in full-time employment growth, relative to their counterparts who do not use the new tax form. Panels c) and d) show that while change in separation rates remains elevated by the end of 2019 for firms hiring formal, part-time workers, the gap in hiring rates closes by the end of the analysis period. Higher separation rates are consistent with more turnover within firms as employer substitute away from full-time employees and towards part-time workers with shorter employment duration. Panel e) shows a temporary reduction in mean daily wages for firms using the new contract type. This finding is consistent with the firms' new hires satisfying the low-wage eligibility requirement of the reform.

IV. Theoretical Framework

In this section we present a theoretical framework that relates labor costs, regulation, and firms' demand for part-time and full-time workers with informality. The model is an extension of Owen (1979) and Montgomery (1988), in which we abstract from the decision of the intensive margin for part-time workers and add a role for regulatory costs and imperfect compliance.

Firms choose the optimal mix of part-time and full-time workers and the share of each of these workers to hire formally or informally. Let E_p and E_f each denote the total number of part-time and full-time workers hired by the firm. The share of part-time and full-time workers that are informally employed is, respectively, $s_p = E_p^{INF}/E_p$ and $s_f = E_f^{INF}/E_f$. Let E be the total number of workers employed at the firm and D_f be work-days per month for a full-time employee. Part-time workers are employed a fraction, $d = D_p/D_f$, $0<d<1$, of the days in a month. We assume d is exogenous and taken as given by the firm.

Following Owen (1979), we allow for imperfect substitutability of part-time and full-time employees using the concept of "idleness" for full-time workers.[27] Suppose there is an optimal proportion of part-time to full-time workers that eliminates idle time $\left(E_p^*/E_f^*\right)$. Deviations from this optimal proportion lead to output loss for any given number of worker-days. To compensate for the output lost due to idleness, firms must hire ℓd full-time worker for every part-time worker below the optimal E_p^*, that is, $E_f - E_f^* = \left(E_p^* - E_p\right)\ell d.$[28] Hence, the total number full-time equivalent workers-days, $L = E/D_f$, employed by the firm is given by equation (3) below:

$$L = \frac{E_p D_p + E_f D_f}{D_f} = E_p d + E_f = E_p d + E_f^* + \left(E_p^* - E_p\right)\ell d \tag{3}$$

Firms are supposed to pay payroll taxes and contribute to their workers' social security. We model these regulatory requirements as the sum of a fixed and a variable labor cost. The variable cost comprises a payroll tax, τ, levied on daily wages. The fixed per worker cost, c, includes the minimum contribution to social security per worker, hiring costs, etcetera. Policies affecting the relative regulatory cost of part-time workers are summarized by a parameter R. If R is equal to 1, it means that the fixed, regulatory cost of a full-time worker is equal to that of a part-time worker such that, per day worked, the cost of part-time work is $1/d$ times higher.

Employers can avoid all regulatory costs by hiring workers informally. Informal employment faces a different cost, $\phi\left(ds_p, s_f\right)$, equal to the expected cost of being caught and fined. We assume this cost is an increasing function of the share of informal workers.

Regulatory costs are summarized in equation (4) below:[29]

$$RC = \tau \times \left(w_p^F d E_p^F + w_f^F E_f^F\right) + c \times \left(R E_p^F + E_f^F\right) + \phi\left(ds_p, s_f\right)$$

$$= \tau \times \left(w_p^F d\left(1 - s_p\right)E_p + w_f^F\left(1 - s_f\right)\left(E_f^* + \left(E_p^* - E_p\right)\ell d\right)\right)$$

[27] See Owen (1979) for a detailed description of the micro-foundations for idleness. Consider for example a firm that faces a predictable pattern of demand throughout the week with high demand on weekends, and low demand on weekdays. Part-time workers are more efficiently used at this firm since full-time workers would be idle on weekdays. Meanwhile, full-time workers are more efficiently assigned to those firms with constant demand throughout the week (or low idleness).

[28] Note that ℓ=1 refers to the case where there are no full-time idle worker-hours, while ℓ<1 represents the case where an hour by part-time workers is less effective than an hour of full-time workers.

[29] Almeida and Carneiro (2012) outline a similar structure for firms' decision to hire formal and informal workers. Their discussion abstracts from part-time work arrangements which, as highlighted in the previous section, is an important driver of heterogeneity in the costs of abiding with labor regulation in Colombia.

$$+c \times \left(R\left(1-s_p\right)E_p + \left(1-s_f\right)\left(E_f^* + \left(E_p^* - E_p\right)\ell d\right)\right) + \phi\left(ds_p, s_f\right) \qquad (4)$$

where w_p^F, w_f^F are wages for part-time and full-time formal workers, respectively,[30] E_k^F is the number of formally employed workers with time-schedule $k \in \{p, f\}$ and $E_k^{INF} = s_k \times E_k$.

Before Decree 2616, an employer would have to make the same contribution to social security for a minimum wage employee working a fraction of the days in a month than for an employee working every day of the month. The reform equalized the fixed regulatory cost of part-time and full-time workers per day worked, such that *R = 1* before the reform and *R=d* afterward.[31]

Non-regulatory costs also include a variable component (wages) and a quasi-fixed one. Non-regulatory quasi-fixed costs include, for example, training and supervision costs. As in Owen (1978), we assume that firms produce with a combination of full-time equivalent jobs with a continuous distribution of quasi-fixed costs, a(j), where a'>0.[32] Non-regulatory variable (VNRC) and quasi-fixed labor costs (QFNRC) are summarized in equations (5) and (6), respectively:

$$VNRC = \left(w_p^F E_p^F + w_p^{INF} E_p^{INF}\right)d + \left(w_f^F E_f^F + w_f^{INF} E_f^{INF}\right)$$
$$= \left(w_p^F\left(1-s_p\right) + w_p^{INF} s_p\right)E_p d + \left(w_f^F\left(1-s_f\right) + w_f^{INF} s_f\right)\left(E_f^* + \left(E_p^* - E_p\right)\ell d\right) \quad (5)$$

$$QFNRC = \frac{1}{ld}\int_{i=\underline{a}}^{L-\left(E_f^*+\left(E_p^*-E_p\right)\ell d\right)} a(i)di + \int_{L-\left(E_f^*+\left(E_p^*-E_p\right)\ell d\right)}^{\overline{a}} a(i)di \qquad (6)$$

Employers choose the cost minimizing number of part-time workers to hire (E_p), and the shares of informal part-time (s_p) and informal full-time (s_f) workers to keep "off-the-books," as stated in the objective function in equation (7):

$$\min_{E_p, s_p, s_f} TC = \min_{E_p, s_p, s_f} RC + VNRC + QFNR \ s.t.\ L = E_p d + E_f^* + \left(E_p^* - E_p\right)\ell d \quad (7)$$

The optimal combination balances the competing costs across contract types (formal vs informal) and work schedules (full vs part-time). When choosing the optimal share of part-time employees, firms equate the marginal quasi-fixed non-regulatory costs, *a*(j),* to the foregone output due to

[30] Both full-time and part-time formal workers are subject to the same minimum daily wage. For generality, we allow the wage to vary across work schedules and formality status. When calibrating the model, we set the daily wage for part-time and full-time formal workers to be equal to the mandatory minimum daily wage.

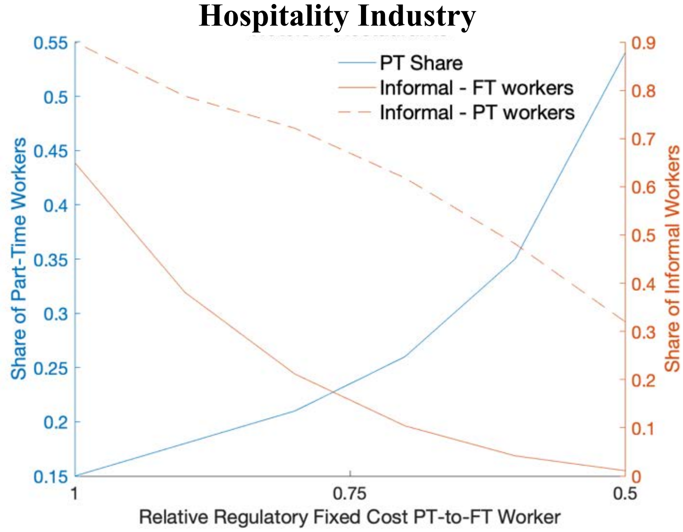
[31] To be precise, discontinuities at d= ¼, ½, and ¾ persisted after the reform. We abstract from these discontinuities and instead note that if firms can choose d, the optimal choice will be at one of the discontinuity points.

[32] Jobs are ranked from least to most costly in terms of these "training costs." The assumption of a distribution of quasi-fixed training costs is an important one since, without it, firms will optimally choose a single type of contract (either part-time or full-time).

idleness. Firms assign part-time workers to jobs with low quasi-fixed costs below an optimal threshold and hire part-time workers for the jobs in the top of the quasi-fixed cost distribution. Simultaneously, for any given demand of part-time work, employers hire workers informally up until the change in the expected cost from getting caught is equal to the additional regulatory costs.[33]

To analyze how the reform changed firms' decisions, we set d=0.5 and pay-roll taxes, τ, equal to 30%. We assume that quasi-fixed costs, $a(i)$, follow a Uniform distribution with a range from 0 to one-fourth of the full-time, minimum wage. We specify the cost of informality function as $\phi(s_p, s_f) = \phi\left(s_f^{\gamma_f} + s_p^{\gamma_p}\right)$. We set the values for the parameters $\phi, \gamma_f, \gamma_p, c$ and ℓ to match the pre-reform share of informal employment among part-time and full-time workers, and the share of part-time employment across different industries in Colombia. We set wages in the formal sector to be equal between part-time and full-time workers, reflecting that the minimum wage per day is binding, and equal, for both groups.

Figure 4: Optimal share of part-time workers, and informality rates for part-time and full-time workers as the relative quasi-fixed regulation costs (R) decline in the Restaurants and Hospitality Industry



Note: The figure shows the predicted shares of part-time workers, and informality rates for part-time and full-time workers for a firm in the restaurant and hospitality industry obtained from counterfactuals where R decreases from 1 to 0.5 keeping all other parameters constant. We choose the rest of the model's parameters to match the industry's share of part-time employment and informality rates prior to the reform.

Besides offering predictions regarding the reform's effect on full-time and part-time formal employment for a particular industry, the model suggests sources of firm heterogeneity that will

[33] Equations C1 to C3 in the Appendix list the first order conditions.

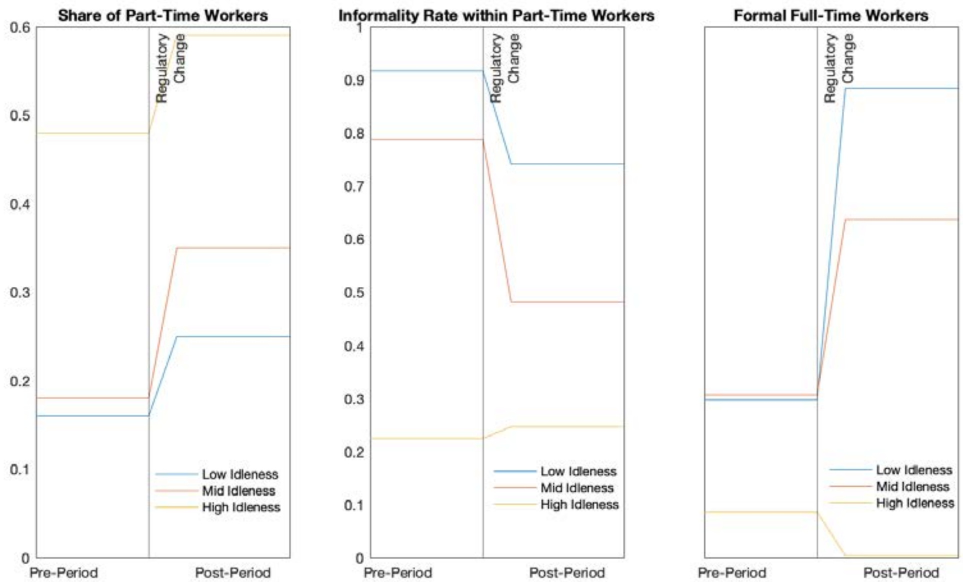
affect their demand for formal, part-time workers and their responses to the reform. Firms in different industries have different production functions and thus face heterogeneous non-regulatory quasi-fixed costs (e.g., the mix of jobs they use as inputs have different training or supervision costs). Moreover, the degree of substitutability between full-time and part-time workers and their relative supply in the local labor market will also affect firms' take-up of type 51 workers and its effect on other outcomes.

We use the model to simulate the response to a discrete decrease in the fixed-regulatory costs of formal employment for part-time workers, such as the one created by the government's policy to allow part-time contributions to pensions. Firms are price takers and face the same regulatory enforcement functions, but there's heterogeneity across sectors in the substitutability of part-time for full-time workers. The degree of substitutability is summarized by the idleness parameter ℓ. Consider, for example, firms in three sectors: one where part-time workers are less effective than full time workers ($\ell < 1$), one where part-time and full-time are close to perfect substitutes ($\ell \approx 1$), and one where full-time workers are less effective than part-time workers ($\ell > 1$). We denote each of these sectors as low, medium, and high idleness sectors, respectively.

Figure 5 plots the change in the share of part-time workers and informality rates for each of the firm types described above. Not surprisingly, full-time workers' idleness is positively correlated with the demand for part-time workers before the reform (see panel (a)). Firms in sectors where full-time workers are idle hire a larger share of part-time workers.

When *R* declines, all firms increase their share of part-time employment, but the magnitude of the effect is not linear: the change in the demand for part-time workers initially increases with idleness but then declines. Idleness affects the demand for part-time workers before the reform, and the magnitude of formalization after the reform (see panel (b)). In this sense, demand for part-time workers before the reform is correlated with firms' take-up of new, formal, part-time employees. As we explain in more detail in section V, we use the heterogeneity in the demand for part-time workers across industries and locations before the regulatory reform to proxy for "idleness" and, hence, for firms' use of the part-time, formal contracts introduced by the reform.

Figure 5: Change in optimal part-time and formality rates after a 50% decrease in relative quasi-fixed regulatory costs for firms in industries with low, medium, and high levels of full-time worker idleness



panel (a) panel (b) panel (c)

Note: The figure shows the predicted shares of part-time workers, and informality rates for part-time and full-time workers for 3 firms each with different levels of idleness (ℓ). We assume the rest of the parameters are the same for all firms. The counterfactual exercise decreases T from 1 to 0.5 keeping all other parameters constant.

V. Empirical Strategy and Results

As outlined in our model in section V, when choosing a job's formality status and work schedule, firms compare the relative productivity of workers under different arrangements and their costs, including wages, taxes, training, and regulatory expenditures. Broadly speaking, these are functions of the firm's production technology, regulatory environment, and labor market characteristics. In this section, we proxy for these parameters using firms' industry and location.

Our model predicts that firms with production technologies that allow for more substitutability between part-time and full-time workers will have 1) higher shares of part-time employment and 2) higher formalization rates for part-time workers. Moreover, after a decrease in quasi-fixed regulatory costs, the change in firms' demand for formal, part-time labor is a non-linear function of full-time workers idleness.

Informed by these theoretical predictions, in our empirical specification, we proxy for the degree of substitutability between full-time and part-time work at each firm using the demand for part-time, low-wage employees in the firm's 2-digit industry and location before the reform (2010-2013). We use the GEIH survey data to calculate the share of part-time workers within the set of employees earning at most twice the monthly minimum wage prior to 2013[34] in each industry-city cell. We group industry-city into quartiles based on their pre-reform share of part-time employment. Then, we merge this information to the PILA administrative records.

Consistent with the model, there is a positive relationship between the demand for part-time workers in each industry-city and the take-up of the new contract type introduced by the reform. Only 1.3 percent of firms in industry-cities with the lowest demand for part-time work in the pre-period regularly use type 51 workers. The share of firms that use the new contract type doubles in industry-cities in the highest quartile of part-time employment before the reform (see table B4 in the Appendix).

We estimate equation (8) on the firm panel data where pt_q is a vector of indicator variables equal to 1 if firm j's sector-city's share of part-time workers before the reform is in the q quartile. λ_{j}, $\gamma_{s\times t}$, and $\delta_{\mathrm{c\times y(t)}}$ are firm, sector-time and city-year fixed effects, and $x'_{j,t}$ is a vector of time-varying firm and city controls. We use two-way clustered standard errors at the industry-city level.

$$Ln(y_{j,t}) = \sum_{q=2}^{4} \beta^q \, pt\_q_{j(s,c)} \times post + x'_{j,t}\alpha + \lambda_{\mathrm{j}} + \gamma_{s\times t} + \delta_{\mathrm{c\times y(t)}} + \varepsilon_{j,c,s,t} \qquad (8)$$

Table 5 below shows the estimated coefficients ($\hat{\beta}^q$) using the specification from equation (8). Each column displays the output using a different dependent variable of interest. We interpret the coefficients as the percentage point difference in growth rates for each quartile relative to the set of firms in the first quartile, where quartiles are defined by the share of part-time employment before the reform. Firms with the lowest demand for part-time work before the reform have the lowest growth rate but the difference decreases with each quartile. The change in total formal employment before and after the reform is 3.6 percentage points higher for firms in the second quartile relative to those in the first quartile. The difference in growth rates drops to 2.8 and 1.6 percentage points respectively for firms in the third and fourth quartiles, both relative to firms in the first quartile. This result is consistent with the reform having heterogeneous effects on full-

[34] There is significant variation in demand for part-time workers and formality rates across cities and industries in Colombia. Figure A3 in the Appendix shows the estimated shares of part-time employment and formal employment using GEIH data.

time and total formal employment, driven by the degree of substitutability between full-time and part-time workers.

Table 5: Differences in Growth Rates After the Reform Relative to Firms in Industry-Cities with Low Shares of Part-time Workers Before the Reform

Quartiles	Formal Workers	Full-Time Formal Workers	Formal Job Hires	Formal Job Separations	Mean Daily Wage	Mean Worker-Days
2	0.036***	0.041***	0.069***	0.039***	-0.003	-0.020***
	(0.009)	(0.010)	(0.007)	(0.007)	(0.005)	(0.003)
3	0.028***	0.032***	0.059***	0.028***	0.006	-0.016***
	(0.008)	(0.010)	(0.007)	(0.006)	(0.005)	(0.003)
4	0.016*	0.018*	0.056***	0.016**	0.007	-0.022***
	(0.009)	(0.010)	(0.007)	(0.007)	(0.005)	(0.003)
R-squared	0.910	0.905	0.570	0.611	0.845	0.503
No. Obs.	7,070,999	7,064,638	7,070,999	7,070,999	7,064,273	7,052,231

Note: This table contains the estimated coefficients on the interaction term from the industry-city share of part-time worker quantiles and the post-reform indicator ($\widehat{\beta^q}$) in equation (8). The first quartile is the baseline group and the coefficients displayed indicate the percent difference in growth rates after the reform relative to the first quartile. In specifications where the dependent variable is a flow (hires and separations), our specification uses the natural logarithm of 1 plus the dependent variable. We exclude firms in city-industry categories with less than 40 employed respondents in the GEIH survey. The estimation sample includes 240,301 firms with at least one active month in 2014 or onwards located in one of Colombia's 23 major cities or any city in Cundinamarca (the state where Bogota is located). Sectors include agriculture, mining, manufacturing, construction, and services. All specifications include firm fixed effects, sector-year-month and city-year fixed effects. We cluster standard errors at the industry-city level.

Hires and separations for formal jobs are also higher after the reform at firms with a higher demand for part-time workers. The change in formal hires is 6.9 percentage points higher in the second quartile relative to the first. Again, the gap closes as demand for part-time workers increases although, in this case, we cannot reject the null hypothesis that the change in hires between the third and first quartile is statistically different from the change in hires between the fourth and first quartiles at a 5 percent significance level. We do not find statistically significant difference in mean wages across firms in the various quartiles defined by demand for part-time workers.

Next, we consider a dynamic version of equation (8) where we replace the post-reform indicator variable with a set of dummies for each quarter in the sample period. We use the time when the reform was announced, the 4th quarter of 2013, as the baseline period. Figure 6 plots the estimated coefficients. Each row presents a different outcome variable, measured in natural logarithms, and each column compares firms in industry-cities from a different quartile of part-time worker demand to firms in the first quartile (i.e., the set of firms in industry-cities with the lowest share of part-time workers before the reform).

The first row, panels a) and b), for Figure 6 show the difference in growth rates in total formal employment and full-time formal employment for each quartile relative to the set of firms with low demand for part-time work before the reform. First, it is important to note that prior to 2014, there is no statistically significant differences in total employment across the various quartiles. After the reform, firms in the second, third and fourth quartile each had higher growth rates for formal employment and full-time formal employment than firms with low demand for part-time work.

Panels c) and d) for Figure 6 show the effect of the reform on labor market flows in the formal sector. While we cannot rule out statistically significant differences for every quarter in the pre-reform period between firms in industry-cities with the lowest shares of part-time employment and firms in quartiles with higher demand for part-time labor, panel c) indicates that prior to the reform formal hires were lower for firms with more demand for part-time work relative to those with low-demand. After 2014, this relationship reverses: the growth rate in formal hires is larger for firms with a higher demand for part-time work before the reform.

Figure 6 panel d) shows no evidence of an impact on mean wages. Meanwhile, consistent with firms with higher demand for part-time workers offering formal jobs to more of these workers after the reform, the mean workdays hired with formal contracts declines after 2014 relative to those firms with low demand for part-time labor (see panel f).

As a test to our empirical specification, Figure 7 shows the mean predicted percent change in full-time, formal employment estimated using equation (8) and its theoretical counterpart estimated using the framework developed in section V. For the model predictions, we calibrate the model's parameters to match the pre-reform shares of part-time workers in each industry-city quantile, as well as the quantile's mean informality rate for part-time and full-time workers.[35] We then simulate the optimal response for a representative firm in each quartile after a reduction in the relative quasi-fixed regulatory costs.[36] The data and the model predict an inverted U-shape for the relationship

[35] Table B5 in the Appendix presents the calibrated parameters and targeted moments.

[36] The counterfactual is a reduction in R from 1 to 0.50.

between change in full-time formal employment after the reform and demand for part-time workers before the reform.

Figure 6: Dynamic Differences in Growth Rates Relative to the Reform Announcement Period (2013 Qtr.4)
Quartile Comparison Versus Firms in Industry-Cities with Low Share of Part-time Workers Before the Reform

2nd Quartile | 3rd Quartile | 4th Quartile

a) Formal Employment

b) Full-Time Formal Employment

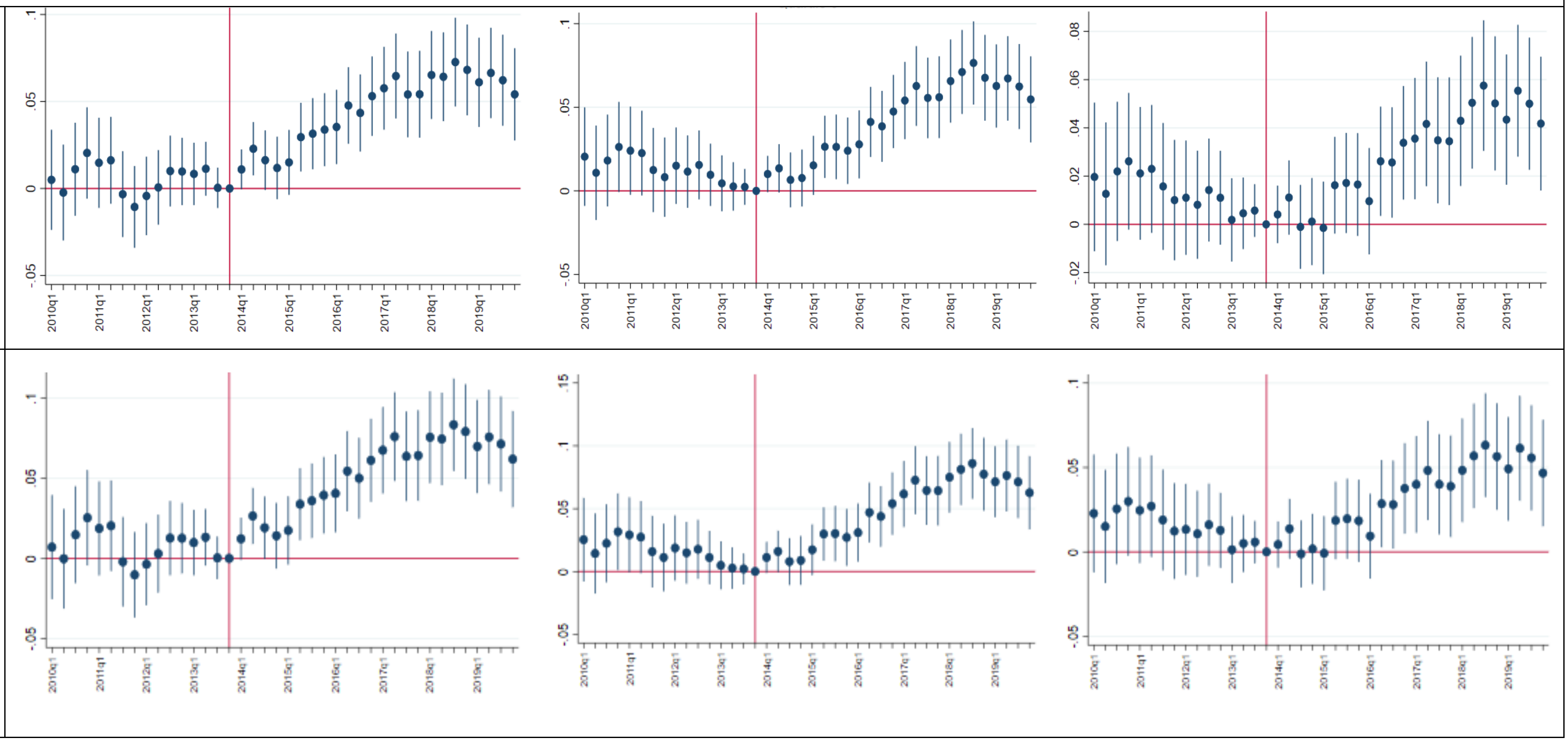


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Figure 6 (continued): Dynamic Differences in Growth Rates Relative to the Reform Announcement Period (2013 Qtr.4) Quartile Comparison Versus Firms in Industry-Cities with Low Share of Part-time Workers Before the Reform

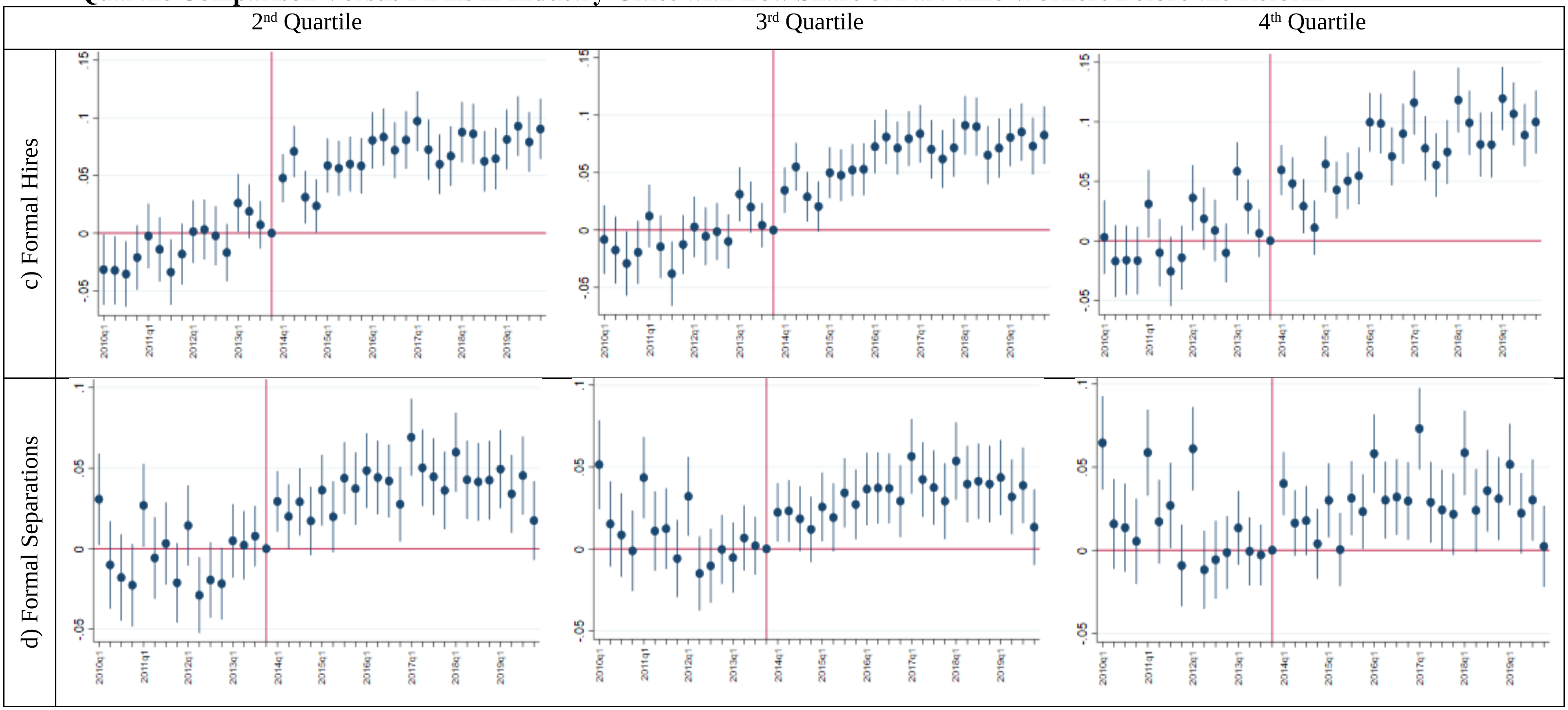

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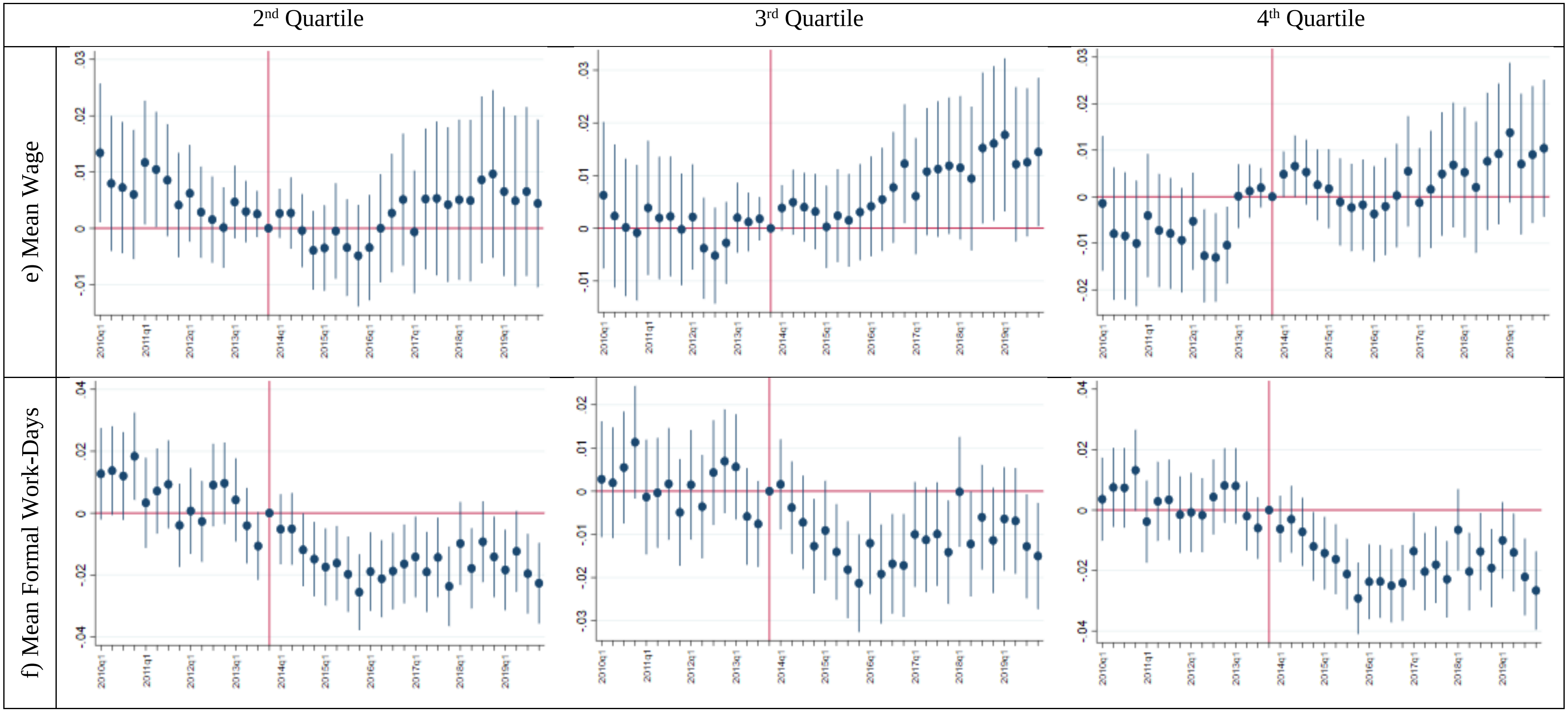
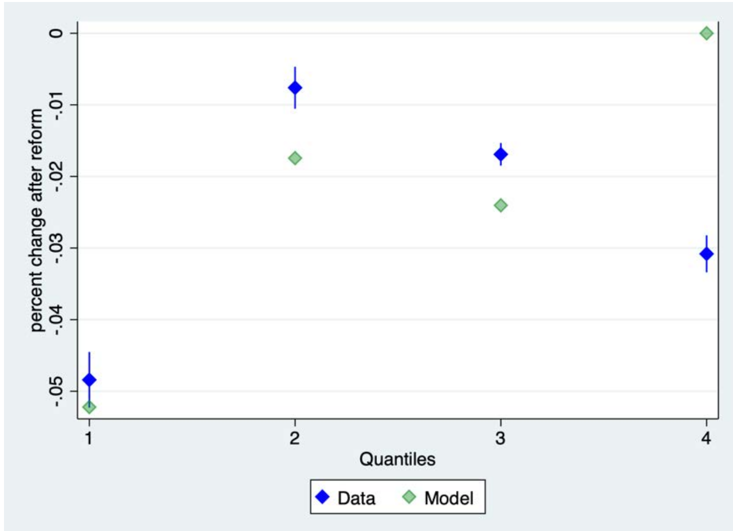
Figure 6 (continued): Dynamic Differences in Growth Rates Relative to the Reform Announcement Period (2013 Qtr.4)



Quartile Comparison Versus Firms in Industry-Cities with Low Share of Part-time Workers Before the Reform

Note: Figure 7 plots the estimated $\hat{\beta}$ coefficients from a dynamic version of equation (8) where we substitute the post indicator variable with a set of quarterly dummies. The baseline period, marked by the vertical red line in each plot, is the 4th quarter of 2013, when the reform was announced. The bars denote 95% confidence intervals. Each dot indicates the difference in the natural logarithm of the outcome variable between the firms in the quartile group indicated in each column and the firms in the lowest quartile ("low demand for part-time work" firms) in quarter *t* relative to the baseline time-period.

Figure 7: Data and Model Predicted Change in Full-time Formal Employment by Industry-City Share of Part-time Work Quartiles



Note: We calculate the model predicted change using the theoretical framework outlined in section V. We set the value of the model's parameters to match the pre-period share of part-time work, and informality shares for each work-schedule in the pre-period (when R = 1). Table B5 in the Appendix presents the values of the parameters and targeted moments. Blue diamonds, labeled "Data," show the predicted percent change in full-time formal employment estimated using equation (8). We exclude firms in city-industry categories with less than 40 employed respondents in the GEIH survey. The estimation sample includes 240,301 firms with at least one active month in 2014 or onwards located in one of Colombia's 23 major cities or any city in Cundinamarca (the state where Bogota is located). We calculate the standard error of the difference in means between the pre and post periods assuming unequal variances with Satterthwaite's correction.

VI. Conclusions, implications, and Policy Recommendations

In this paper, we study a reform to social security regulation in Colombia. The reform reduced a wedge in the relative cost of part-time and full-time labor under formal contracts by allowing the tax base for social security contributions to vary based on each employee's work schedule. Moreover, prior to the reform, workers automatically transitioned to the contributory healthcare system upon entering the formal sector. The reform unbundled contributions to the formal pension system from participating in the subsidized, non-contributory healthcare program. In so doing, Decree 2616 decreased the net costs of formal contracts.

Our results indicate that the policy successfully increased new entries into the pension system that were focused on the targeted group: previously informal, part-time workers. Workers who satisfy both eligibility criteria have a higher probability of contributing to the pension system for the first time in their labor market history (5.4 percentage points higher) after the reform. Meanwhile, workers who satisfy only one of the requirements have lower probabilities of entering the formal sector for the first time after the reform. Using social security administrative records, we do not find evidence of firms attempting to bypass requirements by under-reporting days worked for their current employees.

We find that the reform had a positive effect on total formal employment, driven by an increase in part-time work that compensated for a decline in formal, full-time employment. After 2014, the year when the reform was implemented, formal employment growth is on average 6 percentage points higher at firms that choose to use the part-time contribution, formal contracts created by the reform (type-51 contracts). This increase in formal employment is driven by the formalization of part-time workers: growth in full-time formal employment was lower at firms using the new, part-time contracts, as these firms substituted full-time, formal workers with part-time formal contracts. Hiring rates under formal contracts are 2.6 percentage points higher for firms using the new contract types after the reform but they also face higher separation rates.

We find a non-linear relationship between the increase in formal employment after the reform and the pre-period demand for part-time workers. Based on a stylized model with part-time work arrangements and informality, we argue that firms' heterogeneous response to the change in the regulatory costs for part-time, formal workers is determined by the degree of substitutability between part-time and full-time work for the firm's industry and location. Grouping firms into quartiles based on the demand for part-time labor at their industry and location before the reform, we find that total formal employment growth rate is 3.6 percentage points higher for firms in the second quartile relative to those in the first quartile. The difference in growth rates drops to 2.8 and 1.6 percentage points respectively for firms in the third and fourth quartiles.

Our findings are consistent with the reform targeting meaningful barriers to contributing to the pension system for part-time employees. Specifically, it mitigated the discontinuity generated by imposing a lower bound to contributions effectively tied to full-time employment. For employees, it generated incentives to contribute to the pension system as it allowed them to keep their subsidized healthcare while reducing the fiscal burden associated with being formally employed.

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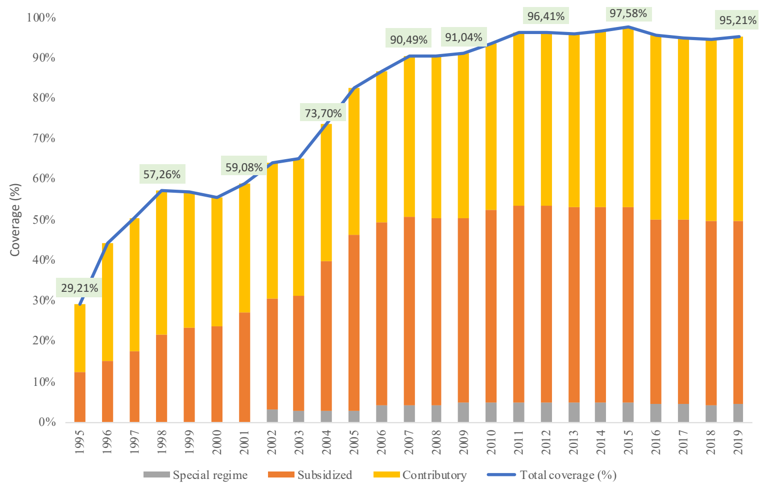
APPENDIX

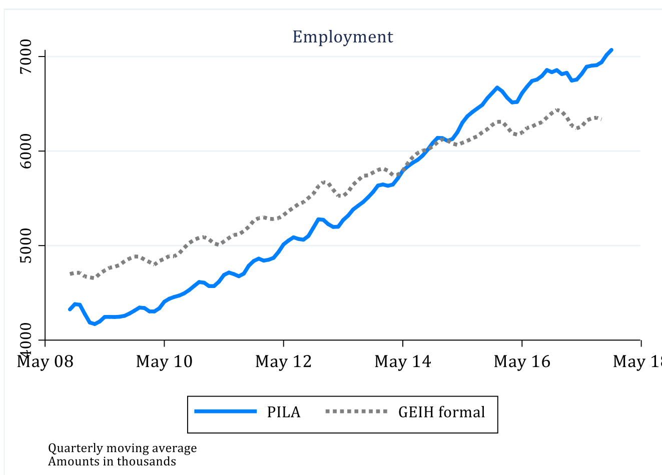
A. Figures

Figure A1: Health-Care Coverage in Colombia, 1995-2019



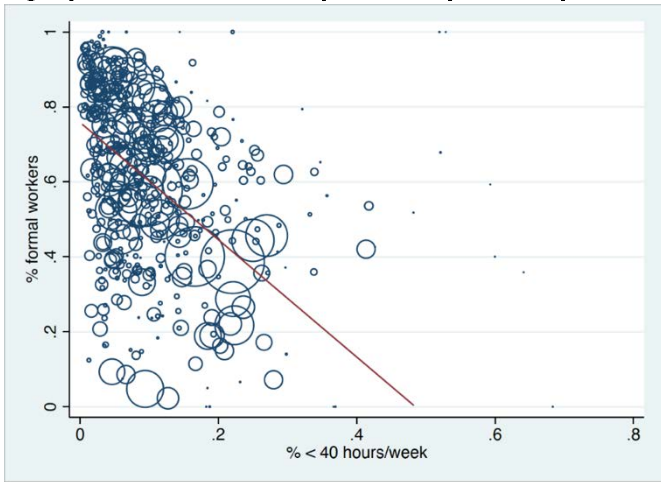
Source: Health Ministry (2019).

Figure A2: Formal Employment PILA and Official Household Surveys



Source: Own calculations using GEIH and PILA.

Figure A3: Part-time Employment and Formality Status by industry-location, 2010 to 2013



Source: Own calculations using data from the GEIH survey. Each circle represents and 2-digit industryXcity. The circle's size indicates the industryXcity total employment.

B. Tables

Table B1. Firm Mean and Standard Deviation from 2014-2019 by Use of Type 51 Workers

	Mode (Type 51 Workers) > 0			
	Yes		No	
	Mean	(std. dev.)	Mean	(std. dev.)
No. of Workers	13.1	(52.11)	18.7	(62.61)
No. of FT Workers	10.87	(47.66)	18.68	(62.59)
Formal Job creation	0.96	(9.77)	1.01	(6.99)
Hires	1.62	(12.45)	1.86	(9.66)
Median wage (2014 $USD)	2,573	(1,717)	2,700	(2,164)
% workers 24	2.02	(10.07)	2.73	(11.48)
% workers 25-44	7.02	(29.78)	10.68	(37.70)
% workers 45-59	3.24	(12.94)	4.41	(15.94)
Age	46.16	(40.15)	56.9	(40.00)
% male workers	0.36	(0.34)	0.56	(0.33)
Ln(Real GDP)	11.16	(1.10)	11.16	(1.12)
No. Active Months	72.68	(46.11)	87.67	(44.42)
No. Obs (Firm-Months)	152,016		5,603,537	
No. Firms	8,809		269,370	

Note: We categorize firms based on the mode across months of the number of type 51 employees. We include only firms with at least one active month in the formal sector between 2014 and 2020. Source: Own calculations using PILA.

Table B2. Workers categories by part-time employment and informality status

	Works part-time with hourly wage above threshold	
	No	Yes
Informal	- Works **more** than 40 hours on an average week - Monthly wage is at or below the monthly minimum wage AND - Has **subsidized health care** OR - Works **less** than 40 hours on an average week - **Hourly wage times 40 is below** the monthly minimum wage. AND - Has **subsidized health care**	- Works **less** than 40 hours on an average week - **Hourly wage times 40 is below** the monthly minimum wage. AND - Has **subsidized health care**
Not informal	**- Same employment conditions as above, without subsidized health care.**	- Same employment conditions as above, **without subsidized health care.**

Note: This 2-by-2 matrix displays the eligibility criteria to make part-time, pension contributions for workers. Only workers satisfying the requirements in the upper right cell can be employed as type-51 workers. The words in bold are meant to highlight the specific requirements that allow or limit a worker's eligibility.

Table B3: Part-time and Formal Worker Share by Industry (2010-2013)

	Percent Part-time	Percent Formal	Percent Total Employment
Agr., Fish. & Mining	6.08	62.15	1.13
Manufacturing	5.77	66.45	19.5
Utilities	2.13	88.34	0.38
Construction	5.51	49.37	5.72
Wholesale & Retail Trade	8.97	57.48	20.34
Hotels & Restaurants	15.29	49.68	16.26
Finance, RE, Prof. Bus. Serv.	7.21	82.37	11.72
Soc., Educ. & Recreation Serv.	12.8	75.9	12.98
Domestic Workers	19.39	26.47	11.96

Note: Part-time workers refers to employees working less than 40 hours per week. We identify formal workers as those that report contributing to the pension system. Source: Own calculations using GEIH data.

Table B4: Demand for part-time work before the reform and share of firms using type-51 contracts in the post period

Quartiles defined based on industry-city share of part-time employment before the reform	Share of Part-time Workers (2010-2013) GEIH data	Share of PILA firms in quartile's industry-city	Share of PILA firms in quartile frequently using type-51 contracts
Q1	6.0	11.3	1.3
Q2	12.0	17.5	1.6
Q4	19.0	49.8	2.3
Q5	56.0	21.4	3.0

Table B5: Model Parameters and Targeted Moments

Panel A. Model Parameters			
Parameter		Description	Target
Exogenous			
τ=0.30		payroll tax (variable regulatory cost)	Set to approximately match taxes on salaried workers in Colombia.
w_f^F		formal wage for full-time workers	Normalized to 1
R = 1		part-time to full-time per-worker regulatory cost	Set equal to 1 before the reform to reflect that the equal minimum contributions for part-time and full-time workers
d=0.50		part-time to full-time days worked per month	Set to reflect half-time work (15 days per month or 20 hours per day)
$\underline{a} = 0, \bar{a} = 0.25$		lower and upper bound for quasi-fixed non-regulatory costs	Set to reflect a maximum quasi-fixed non-regulatory cost equal to ¼ of the full-time, formal wage.
Calibrated (common for all firms)			
c=0.3065		regulatory quasi-fixed cost	Calibrated to match quartiles shares of part-time, informal part-time and informal full-time workers.
ϕ=0.5345		informality penalty	
$\gamma_f = 1.1352,$ $\gamma_p = 0.085$		cost of informality elasticities for the share of informal full-time and informal part-time workers	
Calibrated (heterogeneous across industry-city quartiles)			
ℓ	1st = 0.7854	part-time to full-time worker substitutability (idleness)	Calibrated to match quartiles shares of part-time, informal part-time and informal full-time workers.
	2nd = 1.0315		
	3rd = 1.1140		
	4th = 1.3769		
w_p^{INF}	1st = 1.0506	informal wage for part-time workers (relative to formal, full-time wage)	
	2nd = 1.4482		
	3rd = 1.6015		
	4th = 1.8018		
w_f^{INF}	1st = 1.3346	informal wage for full-time workers (relative to formal, full-time wage)	
	2nd = 1.3252		
	3rd = 1.3093		
	4th = 1.1265		
w_p^F	1st = 0.992	formal wage for part-time workers (relative to formal, full-time wage)	
	2nd = 1		
	3rd = 1		
	4th =1		

Panel B. Targeted Moments			
Quartile	Share of Part-time Workers (max)	Share of Informal Workers for Part-time Employees (mean)	Share of Informal Workers for Full-time Employees (mean)
1	0.06	0.88	0.56
2	0.12	0.80	0.50
3	0.19	0.75	0.46
4	0.56	0.71	0.60

C. Equations

Equations (C1) to (C3) list the first order conditions for the firm's optimization problem described in equation (6) in the main text. Let $\omega^F = \frac{w_p^F}{w_f^F}$, $\omega^{INF} = \frac{w_p^{INF}}{w_f^{INF}}$, $\mathcal{S} = \frac{1-s_p}{1-s_f}$, $v_p = \frac{w_p^{INF}}{w_p^F}$, $v_f = \frac{w_f^{INF}}{w_f^F}$, and a^* is the training cost for the marginal part-time worker.

$$\frac{\delta TC}{\delta E_p} = (1 - s_f)d\left[w_f^F(\omega^F\mathcal{S} - \ell)(1+\tau) + c\left(\frac{R}{d}\mathcal{S} - \ell\right)\right] + dw_f^{INF}(\omega^{INF}s_p - s_f\ell) - a^*(1 - \ell d) = 0 \quad \text{(C1)}$$

$$\frac{\delta TC}{\delta s_p} = \frac{\delta\phi}{\delta s_p}d - E_p d w_p^F\left(1 + \tau + \frac{c}{w_p^F} - v_p\right) = 0 \quad \text{(C2)}$$

$$\frac{\delta TC}{\delta s_f} = \frac{\delta\phi}{\delta s_f} - \left(E_f^* + (E_p^* - E_p)\ell d\right)w_f^F\left(1 + \tau + \frac{c}{w_f^F} - v_f\right) = 0 \quad \text{(C3)}$$